INTRODUCTION TO WHEAT MANAGEMENT

Figure 1. Wheat crop at physiological maturity.

Soft red winter wheat is the predominant class of wheat grown in Missouri. This class of wheat is characterized as having a low to medium protein content, a soft endosperm and a high yield potential. The principal use of soft red winter wheat is in the baking industry, where it is used to make cakes, pastries, flat breads and crackers.

Since 1970, Missouri continuously has been ranked as one of the top five soft red winter wheat-growing states. Currently, Missouri ranks third in total production behind Arkansas and Ohio. In 2003, Missouri growers harvested 870,000 acres of wheat with a state average yield of 61 bu/acre.

The environmental variability among the soft red winter wheat-growing regions within Missouri dictates that regionalized recommendations are needed to assess potential crop and pest management issues. Understanding the impact of crop and pest interactions at specific crop-growth stages is important in maximizing crop yield.

The goal of this publication is to provide Missouri growers information with which to make both timely and accurate crop and pest management decisions.

IDENTIFYING CROP-GROWTH STAGE

Accurate identification of crop-growth stage is important in managing winter wheat. Of the cereal grain development scales currently in use, the Feekes and Zadoks scales are the most common. One advantage of using a uniform plant identification system, such as the Feekes or Zadoks scale, is enhanced communication among growers, research and extension faculty, and consultants. These systems also aid in developing precise and timely recommendations that address crop and pest management concerns.

Both the Feekes and Zadoks scales are extremely useful. The Zadoks scale, however, is more descriptive and may prove more valuable in communicating crop-growth stage. The advantage that the Zadoks scale has over the Feekes scale is that more than one descriptive value may be assigned to each plant. For example, if a plant has four leaves and one tiller, the Feekes scale will identify that plant as a Feekes: 2, whereas the Zadoks scale will identify the same plant as Zadoks: 14, 21.

Another example would be if a plant had five leaves, three tillers and one detectable node. The Feekes scale would identify that plant as Feekes: 6, whereas the Zadoks scale would identify the same plant as Zadoks: 15, 23, 31.

The increased precision in describing crop-growth stage may improve crop and pest management recommendations. The most difficult task in describing crop-growth stage is determining leaf number and tiller number. To determine the former, position the plant so that the first true leaf is on the left. Since winter wheat has an opposite leaf arrangement, the next leaf will be on the right side of the plant. The next leaf would be counted only if that leaf were at least half the length of the preceding leaf. This method is continued up the entire stem until all the leaves are identified.

It is important that tillers be differentiated from leaves and counted separately. To distinguish tillers from leaves, look for the presence of an independent sheath called a prophyll, which is

Table 1. Soft red winter wheat crop-growth stages.

Visual description	Zadoks	Feekes
Germination		
Dry seed	00	
Start of imbibition	01	
Imbibition complete	03	
Emerged radicle	05	
Emerged coleoptile	07	
Leaf at coleoptile tip	09	
Seedling growth		
First true leaf	10	1
First leaf unfolded	11	
2 leaves unfolded	12	
3 leaves unfolded	13	
4 leaves unfolded	14	
5 leaves unfolded	15	
6 leaves unfolded	16	
7 leaves unfolded	17	
8 leaves unfolded	18	
9 or more leaves	19	
Tillering		
Main shoot only	20	
Main shoot and 1 tiller	21	2
Main shoot and 2 tillers	22	
Main shoot and 3 tillers	23	
Main shoot and 4 tillers	24	
Main shoot and 5 tillers	25	
Main shoot and 6 tillers	26	3
Main shoot and 7 tillers	27	
Main shoot and 8 tillers	28	
Main shoot and 9 or more tillers	29	
Stem elongation		
Pseudostem erection	30	4-5
1st detectable node	31	6
2nd detectable node	32	7
3rd detectable node	33	
4th detectable node	34	
5th detectable node	35	
6th detectable node	36	
Flag leaf visible	37	8
Flag leaf ligule and collar visible	39	9

Visual descripion	Zadoks	Feekes
Booting		
Flag leaf sheath extending	41	
Boot swollen	45	10
Flag leaf sheath opening	47	
First visible awns	49	
Inflorescence emergence		
First inflorescence spikelet visible	50	10.1
1/4 of inflorescence visible	53	10.2
1/2 of inflorescence visible	55	10.3
3/4 of inflorescence visible	57	10.4
Inflorescence completely emerged	59	10.5
Anthesis		
Anthesis begins	60	10.51
1/2 of anthesis complete	65	
Anthesis complete	69	
Mild development		
Kernel watery ripe	71	10.54
Early milk	73	
Medium milk	75	11.1
Late milk	77	
Dough development		
Early dough	83	
Soft dough	85	11.2
Hard dough	87	
Ripening		
Kernel hard (hard to split by thumbnail)	91	11.3
Kernel hard (cannot dent by thumbnail)	92	11.4
Kernel loosening in daytime	93	
Overripe	94	
Seed dormant	95	
Viable seed has 50% germination	96	
Seed not dormant	97	
Secondary dormancy	98	
Secondary dormancy lost	99	

Source: Adapted from J.E. Nelson, K.D. Kephart, A. Bauer, and J.E. Conner. 1988. Growth staging of wheat, barley, and wild oat. MSU Coop. Ext. Ser., Bozeman, Mont., and Univ. of Idaho Coop. Ext. Ser., Moscow, Idaho.

located at the base of each tiller. Unlike leaves, tillers are counted as soon as they emerge.

Once the leaf number and the tiller number have been identified, the subsequent key characteristics to be noted are node formation, flag leaf emergence, boot stage, head emergence, flowering and finally grain development.

To classify crop-growth stage, identify the following characteristics in order (refer to Table 1 for corresponding numerical assignment):

- Number of leaves on the main shoot.
- Number of tillers.
- Number of nodes.
- Flag leaf emergence.
- Boot stage initiated.
- Head emergence.
- Flowering or anthesis.
- Grain developmental stage.

KEY COMPONENTS OF WINTER WHEAT YIELD

To manage a winter wheat crop, it is important to know the key growth stages at which yield potential is determined. The components that directly affect wheat yield are tiller and head number, head size, kernel number and kernel size. Precise timing of crop and pest management practices at these key crop-growth stages will aid in maximizing crop yield.

- Tiller and head number: maximum number of tillers that form heads is determined by jointing (Feekes: 6; Zadoks: 31).
- Head size: head size is a function of the number of kernels per spikelet and is determined from mid to late tillering (Feekes: 3; Zadoks: 25 to 29).
- Kernel number per spikelet: the number of kernels per spikelet is determined at jointing (Feekes: 5-6; Zadoks: 30-31).
- Kernel size: kernel size is determined by resource availability (water and nutrients) and crop health beginning at flag leaf emergence and continuing through grain fill (Feekes: 8; Zadoks: 37).

AGRONOMIC PRACTICES

Variety selection

When choosing a soft red winter wheat variety, several factors must be considered. These include insect, disease and herbicide resistance characteristics and winter survival, as well as heading date, lodging, test weight and yield. Since no variety is ideal for every location, it is important to understand the crop environment and pest complex that affects a specific region in order to maximize yield.

Variety selection begins by choosing a variety that is adapted to the environmental conditions and cropping system that a grower employs. For example, in northern Missouri, it would be important to select a variety that has excellent winter survival, as well as a delayed heading date to decrease the risk of a spring frost that may affect crop yield. In central or southern Missouri, it may prove more important to select a variety that has an early heading date and early maturity date to decrease the risk of an early fall frost that may affect the double-crop soybean yield.

Crop height and lodging potential also are important varietal characteristics that may be affected based on cropping system. If the wheat crop is intended for grain only, it may be important to select a variety that is short statured and has a low potential for lodging. This may decrease yield loss due to crop spoilage and harvest loss as well as increase harvest rate. However, if the wheat crop is to be used as silage or to be harvested as both grain and straw, then selecting a taller variety may be warranted.

Select a variety that has the specific insect, disease and herbicide resistance characteristics that fit the regional needs. By selecting the appropriate resistant varieties, a producer can either reduce or avoid crop yield loss without the need of pesticides. Careful management of resistant cultivars through crop and variety rotation is required to ensure that these characteristics are not lost.

Test weight is also an important factor to consider when selecting a variety. The minimum test weight to be considered, a U.S. #2 soft red winter wheat, is 58 lb/bu. Wheat with a test weight lower than 58 pounds will be discounted.

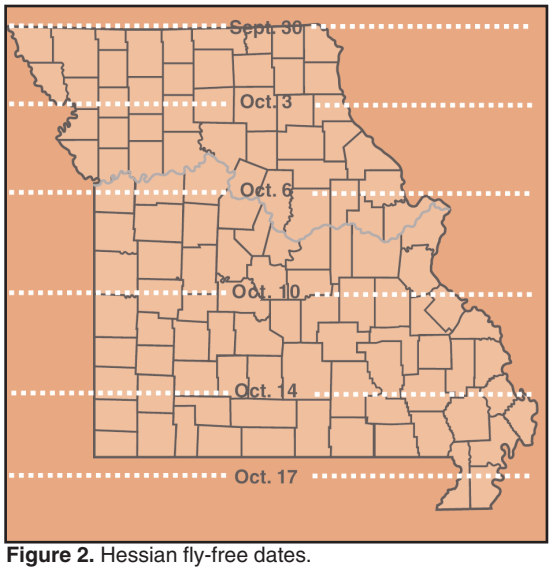

Figure 2. Hessian fly-free dates.

Both environment and pests can greatly affect test weight; therefore, selecting a variety that has a high test-weight potential in your region is critical to maximize economic gain.

Yield is based on the genetic potential and environmental conditions in which the crop is grown. Therefore, by diversifying the genetic pool that is planted, a grower will hedge against crop failure. By understanding the environment and the pest complex in a particular region, growers can make better variety selections, which will increase crop yield.

Seed quality

The next step in maximizing crop yield is to plant clean, high-quality seed that is either plant certified or private seed that is true to variety and has a high germination percentage (greater than 90 percent). Seed size is also an important factor in determining seed quality. Select varieties that have large, dense kernels and a thousand kernel weight (TKW) greater than 30 grams. Wheat seed with TKW values greater than 30 grams tends to have increased fall tiller number and increased seedling vigor.

If saved seed is to be planted, it is critical to clean the seed. Cleaning will remove weed seed, chaff and small and broken seeds, thus increasing seed quality and TKW. It is also important to perform a germination test. If the germination percentage is below 90 percent, increase the seeding rate accordingly; however, do not plant seed with a germination test below 80 percent. If it is known beforehand that seed is to be saved, scout and choose seed from fields where diseases and weeds were minimal.

Planting date

The optimal planting date for soft red winter wheat for Missouri is based on the Hessian fly-free date, which varies at regular intervals from south to north (Figure 2). Planting before this date increases the risk of yield loss associated with Hessian fly damage and also increases risk of aphid feeding and transmission of barley yellow dwarf virus. Planting significantly later than this date increases the risk of poor crop establishment and decreased tiller number, both of which may affect crop yield.

Planting rate and depth

The targeted fall stand for wheat seedlings is between 30 and 35 plants per square foot. To achieve this goal, the planting rate for soft red winter wheat is between 1,300,000 and 1,500,000 seeds per acre. Depending upon varietal seed size (thousand kernel weight), this equates to a range of between 74 and 119 pounds of seed per acre (Table 2). Growers may choose to use the lower seeding rate if planting conditions are ideal. However, increasing the seeding rate under poor planting conditions in no-till production systems or when the planting date is significantly delayed may prove beneficial.

Table 2. Wheat seeding rate in pounds per acre based on thousand kernel weight.

Pounds of seed per acre		
Thousand kernel weight	1,300,000 seeds	1,500,000 seeds
26.0 grams	74.4	85.9
28.0 grams	80.2	92.5
30.0 grams	85.9	99.1
32.0 grams	91.6	105.7
34.0 grams	97.4	112.3
36.0 grams	103.1	118.9

Wheat may be planted ½ to 1½ inches deep, depending upon soil moisture conditions. Wheat planted less than ½ inch deep may result in uneven germination due to seed exposure or dry soil condition. Wheat planted more than 1½ inches deep may result in death due to premature leaf opening or poor tiller development and winter survival. Uniform seed placement and seeding depth are important in promoting crop health in the fall.

References

J.E. Nelson, K.D. Kephart, A. Bauer, and J.E. Conner. 1988. Growth staging of wheat, barley, and wild oat. MSU Coop. Ext. Ser., Bozeman, Mont., and Univ. of Idaho Coop. Ext. Ser., Moscow, Idaho.

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